CLAIMS

I claim:

1. A focused laser irradiation apparatus for imaging the dose rate response of a semiconductor device, comprising:

   a laser providing a beam of laser light of a wavelength,

   means for focusing the laser beam to a focal spot on the surface of the semiconductor device,

   means for scanning the focused laser beam at a plurality of spatial locations on the surface of the semiconductor device,

   means for pulsing the focused laser beam to provide a laser light pulse having a pulse width at each of the spatial locations on the surface of the semiconductor device to provide a charge collection signal at each of the spatial locations, and

   means for processing the charge collection signal from each of the spatial locations to provide a dose-rate response image of semiconductor device.

2. The focused laser irradiation apparatus of claim 1, wherein the laser comprises an infrared laser diode.

3. The focused laser irradiation apparatus of claim 1, wherein the wavelength of the laser light is about 1064 nanometers or less.

4. The focused laser irradiation apparatus of claim 1, wherein the wavelength of the laser light is about 904 nanometers or less.

5. The focused laser irradiation apparatus of claim 1, wherein the pulse width of the laser light is less than 10 microseconds.

6. The focused laser irradiation apparatus of claim 1, wherein the pulse width of the laser light is less than 100 nanoseconds.

7. The focused laser irradiation apparatus of claim 1, wherein the spot size of the focused laser beam is less than 10 microns in diameter.

8. The focused laser irradiation apparatus of claim 1, wherein the semiconductor device comprises a silicon integrated circuit.

9. The focused laser irradiation apparatus of claim 1, wherein the processing means comprises:

at least one amplifier for measuring the charge collection signal from the semiconductor device in response to each focused laser beam pulse at each spatial location,

at least one digital-to-analog converter for providing a digital output corresponding to the magnitude of the measured charge collection signal at each spatial location,

a computer for combining the digital outputs from each of the plurality of spatial locations to provide the dose rate response image of the semiconductor device.

10. The focused laser irradiation apparatus of claim 1, further comprising means for measuring the time delay between the laser light pulse and the charge collection signal at each spatial location.

11. The focused laser irradiation apparatus of claim 10, wherein the measuring means comprises:

means for detecting the trigger signal to the pulsing means to provide a trigger signal pulse,

a constant fraction discriminator for detecting the charge collection signal to provide a charge collection signal pulse, and

a time-to-amplitude converter to convert the time delay between the trigger signal pulse and the charge collection signal pulse to provide an output pulse with amplitude proportional to the time delay.

12. The focused laser irradiation apparatus of claim 10, further comprising a computer for combining the time delay measurements from each of the plurality of spatial locations to provide a time-delay image of the dose-rate response of the semiconductor device

13. A method for dose-rate response imaging of a semiconductor device, comprising:

exposing each spatial location of a plurality of spatial locations on the surface of the semiconductor device to a pulse of laser light from a focused laser beam to provide a charge collection signal at each spatial location, and

processing the charge collection signal from each of the spatial locations to provide a dose-rate response image of the semiconductor device.

14. A method for monitoring the aging of a semiconductor device, comprising:

imaging the charge collected at a first time by the active regions of the semiconductor device from exposure to a laser light pulse from a focused laser beam at each spatial location of a plurality of spatial locations on the surface of the semiconductor device to provide a first dose-rate response image,

imaging the charge collected at a second time by the active regions of the semiconductor device from exposure to a laser light pulse from the focused laser beam at each of the spatial locations on the surface of the semiconductor device to provide a second dose-rate response image, and

comparing the second dose-rate response image to the first dose-rate response image.

15. The method of claim 14, further comprising detecting from the comparing at least one spatial location of the plurality of spatial locations wherein the second dose-rate response image has changed from the first dose-rate response image.

16. The method of claim 15, further comprising analyzing the materials of the semiconductor device at the at least one spatial location to determine the physical cause of the changed dose-rate response image.

17. A method for time-delay imaging of the dose-rate response of a semiconductor device, comprising;

exposing each spatial location of a plurality of spatial locations on the surface of the semiconductor device to a laser light pulse from a focused laser beam to provide a charge collection signal, and

measuring the time delay of the charge collection signal from each of the spatial locations to provide a time-delay image of the dose-rate response of the semiconductor device.

18. A method for monitoring the aging of a semiconductor device, comprising:

measuring the time-delay image of the dose-rate response of the semiconductor device at a first time,

measuring the time-delay image of the dose-rate response of the semiconductor device at a second time, and

comparing the time-delay image measured at the second time to time-delay image measured at the first time.

19. A method for determining the thickness of a thin film layer over the active region of a semiconductor device, comprising:

exposing each spatial location of a plurality of spatial locations on the surface the thin film layer to a laser light pulse from a focused laser beam to provide a charge collection signal at each spatial location, and

processing the charge collection signal from each of the spatial locations to provide a dose-rate response image of the semiconductor device resulting from the laser light pulse that passes through the thin film layer.

20. The method of claim 19, further comprising determining the processed charge collection signals at each of the spatial locations to identify at least one thickness anomaly in the thin film.

21. A method for dose-rate failure testing, comprising:

exposing a semiconductor logic device to a broad-beam laser pulse having a laser pulse width and a laser deposited energy,

measuring an electrical property of the semiconductor logic device from the exposing step.

22. The method for dose-rate failure testing of claim 21, further comprising repeating the exposing and measuring steps for at least one different broad-beam laser pulse at a different laser deposited energy and comparing the measured electrical property to a specified value to determine a deposited energy dependence of the failure of the semiconductor logic device.

23. The method for dose-rate failure testing of claim 21, further comprising repeating the exposing and measuring steps for at least one different broad-beam laser pulse at a different laser pulsewidth can comparing the measured electrical property to a specified value to determine a pulsewidth dependence of the failure of the semiconductor logic device.

24. The method of dose-rate failure testing of claim 21, further comprising injecting at least one electrical transient into a power line of the semiconductor logic device during the exposing step.

25. The method of dose-rate failure testing of claim 21, further comprising time-varying the intensity of laser pulse width.